

THIN-FILM RELIABILITY AND ENGINEERING OVERVIEW

JET PROPULSION LABORATORY

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Scope

- Development of the reliability and engineering technology base required for thin-film modules
 - Emphasis on amorphous-silicon
 - Emphasis on module and array-level issues
 - De-emphasis of cell-intrinsic reliability issues such as light-induced effects
- Closely coordinated with SERI's thin-film cell research activities as a part of DOE's Amorphous Silicon Program, managed by Ed Sabisky

Thin-Film Differences Requiring New or Expanded Research

- New cell environmental durability (temperature/humidity/UV) failure modes
- Altered hot-spot heating failure mechanisms
- Short-circuit cell failure modes and effect on cell size and series/parallel redundancy
- New cell electrical interconnect failure modes
- Altered glass breaking strength
- Flexible substrate technology demands
- High cell stresses due to glass bending
- Non-linear electrical response and effect on module measurement
- Cell-to-cell electrical variability and effect on electrical mismatch and circuit design

MODULE DEVELOPMENT AND ENGINEERING SCIENCES

R&ES Crystalline-Si Research Applicability to Thin-Film Modules

- Circuit reliability model development ①
- Interconnect mechanical fatigue ○
- Electrical insulation breakdown research ●
- Glass-fracture mechanics ①
- Cell-fracture mechanics ○
- Cell temperature/humidity endurance (Clemson) ①
- Module temperature/humidity endurance (Wyle) ①
- Module hail-impact resistance ①
- Optical-surface soiling ●
- Electrochemical corrosion ①
- Encapsulant photo-thermal degradation ●
- Encapsulant debonding ●
- Hot-spot heating ①
- Bypass diode integration studies (GF) ●
- Module flammability and arcing research (UL) ●

● = generally applicable, ○ = significant changes

FY85 R&ES Thin-Film Research Thrusts

- Temperature-humidity reliability research
- Glass breaking strength research
- Point defect system analysis
- Hot-spot heating assessment
- Electrical measurements technology development

MODULE DEVELOPMENT AND ENGINEERING SCIENCES

Temperature-Humidity Reliability Research

- **Objective**
 - Assess stability of α -Si cells in T/H environments
 - Assess requirements for encapsulation
- **Status**
 - Initial α -Si cell samples acquired (ARCO, Sanyo, Chronar)
 - Additional samples procurements underway (Hughes and Chronar)
 - Exploratory tests initiated at Clemson

Glass Breaking-Strength Research

- **Objective**
 - Determine breaking strength versus α -Si processing
 - Assess need for glass strength enhancement
 - Develop glass strength enhancement techniques
 - Develop glass support techniques
- **Status**
 - FY 1985 start, building on extensive experience with glass on crystalline-Si modules
 - Tin-oxide-coated glass samples acquired from Chronar for test

Point-Defect System Analysis

- **Objective**
 - Assess present areal density levels of defects
 - Assess economic penalty/allowable levels for defects
 - Determine optimum cell interconnection/geometry to minimize impact
- **Status**
 - Computer program operational for computing system power loss due to shorted cells
 - Laser scanner being modified to allow defect mapping

MODULE DEVELOPMENT AND ENGINEERING SCIENCES

Hot-Spot Heating Assessment

- Objective
 - Establish susceptibility of α -Si cells to hot-spot phenomena
 - Establish bypass diode recommendations for modules
- Status
 - Just initiated

Electrical Measurements Technology Development

- Objective
 - Establish means for accurate repeatable measurement of electrical I-V performance of α -Si cells and modules
- Status
 - LAPSS verified as appropriate light source
 - Filters identified to convert LAPSS to AM 1.5 global spectrum
 - Filters identified to alter crystalline-Si spectral response to provide reference cells for α -Si

Research Forum on Reliability and Engineering of Thin-Film Modules (San Diego, Feb. 18-20, 1985)

Focus: Reliability and performance issues relating to integrating α -Si cells into power modules, including a review of current status, identification of problem areas, a definition of needed research.

Tentative Agenda

- Cell performance overview
- Module reliability considerations
- Module performance considerations
- Electrical performance measurement